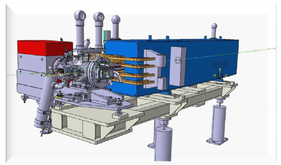
Canadian Light Source — Centre canadien de rayonnement synchrotron

MEDSI 2008



A SECOND GENERATION OF CROTCH ABSORBER FOR ESRF UPGRADE

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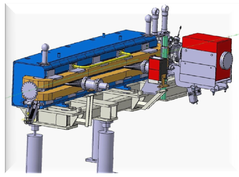


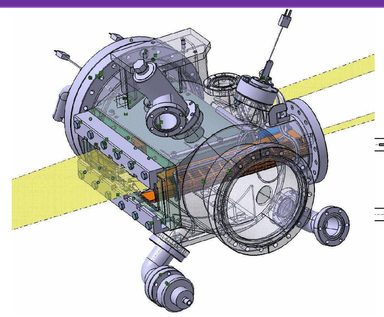
Introduction

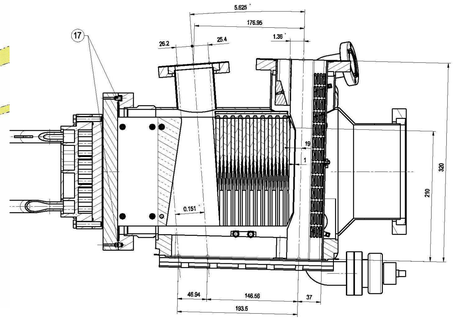
The 6-Gev European Synchrotron Facility (ESRF) storage ring operates at 200mA beam current. The storage ring operation at higher current is part of the upgrade program . It is planned to run at 300mA which is 50% higher than present operational e-beam current(200mA). At 200mA the actual Glidcop absorber is operated close to the elastic limit (Yield strength) of the material. A possible current of 500mA has also to be considered and a new design must be worked out.

At the ESRF there are 64 bending dipoles with soft end, the max field strength B is 0.857T, B(soft-end)=0.40T. Each dipole bends the circulating electron beam by 5.6 degrees (98.17 mrad) generating a X-ray fan tangent to the beam trajectory. Only a few mrad of this fan exits through the front-end port, the rest of the fan is intercepted by absorbers designed to protect the vacuum chambers and in particular the crotch absorber takes about two-thirds of it (8.16kW at 200mA which gives 20kW at 500mA).

The Vacuum Chamber

Concerning the crotch absorber positioning, after some adjustment principle have been envisaged, a non adjustable interface is the chosen option. The corect positioning will be obtained by a precise machining of the two parts, thus avoiding a complicated adjustable interface.





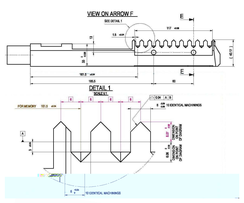
The Absorber

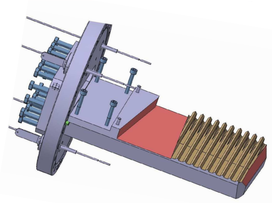
Crotch Absorber Description

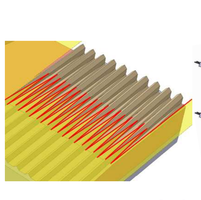
The Absorber is composed of two horizontal Glidcop Jaws each side of the beam fan plan. Each jaw is shaped with double–slope compact design teeth. The teeth imbricate in such a way that the power deposit must be equally spread on both the jaws within a range of +/- 3mm in the vertical position of the beam.

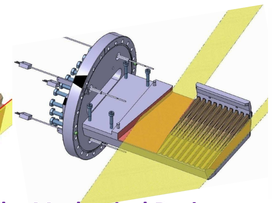
The final dimensions and orientations of the teeth have been optimized by FEA calculations combining temperature and thermal stress considerations testing different geometries (different sizes and different angles). After a certain number of iterations we obtain a tooth shape which theoretically gives three times less stress than the existing design in the same conditions..

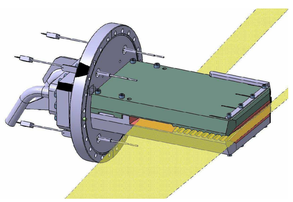
For the prototype we took the choice of adding the flat absorber function to the crotch absorber by putting its edge at a distance of 19mm instead of 35mm from to the electron beam. In that configuration the maximum acceptable current is reduced to 400mA.











Key Points Of The Mechanical Design

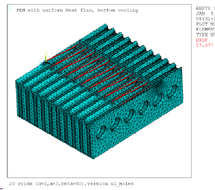
The teeth are 6mm large with two top faces at 45º and with a 3º general inclination. Between each tooth a gap of 6mm allow the teeth of the opposite jaw to imbricate. All the teeth are parallel to each other and perpendicular to the absorber body. The absorber is then oriented so that its ending teeth (on the side of the e beam) are parallel to the local X-ray to optimize the power distribution in this most loaded zone. Because there are some teeth parallel to the X-ray beam it has been necessary to add a screen on the downstream side of the absorber to intercept the possible beam leak through the small play between the teeth.

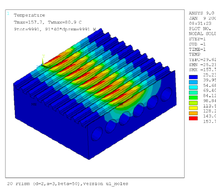
Choice Of The Materials

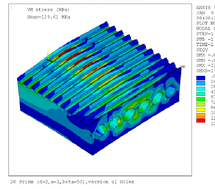
Because of its high thermal conductivity, high strength and UHV compatibility, Glidcop (AL15) has been selected.

Finite Elements Analyses

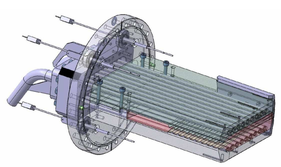
The calculated maximum temperature is 157°C and the Von Mises stress is 130Mpa for 200 mA e-beam current

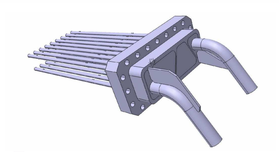






Cooling



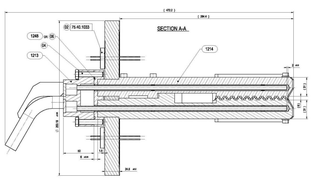


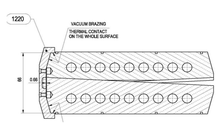
For The Cooling

Deionised water is used because of its availability and performance.

Cooling channels will be designed to be at a distance from the beam plan to suppress the risk of corrosion due to the interaction of the X-ray beam, water and copper. Water velocity must be in the 3-4 m/s range in order to maintain a sufficient heat transfer without generating vibrations or erosion/cavitations.

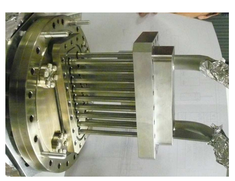
Water to vacuum brazes or weld joints are not used for protecting the storage ring vacuum from potential water leaks.





Each jaw includes nine longitudinal drilled channels of a diameter of 10mm into which run Ø8-6mm tubes coming from a water box. The section of the water box which supports the tubes can be remove and the arrangement of the tubes is such that there are a series of six times three tubes in parallel.

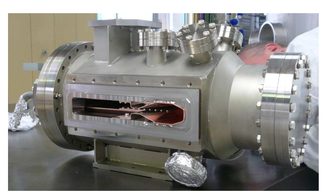
With this configuration a flow rate of 19l/min have been measured under a pressure drop of 5 bars, which correspond to a flow speed of 3.7m/s.

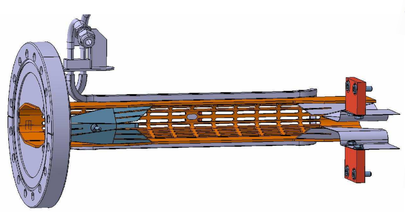


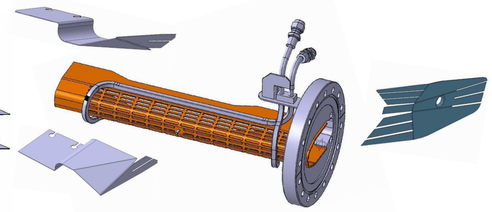
Radio Frequency Features

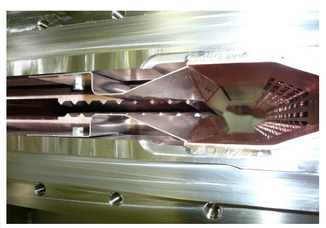
In order to guarantee a good RF behaviour the vacuum chamber is equipped along the electron beam with a grid sheet keeping the RF continuity with the upstream and downstream chamber. For thermal reasons this grid is in copper with a water cooling tube brazed on it.

On the prototype the end of the absorber is close to the e-beam and to avoid damage coming from the image current we have inserted contact fingers upstream and downstream of the absorber block.









ACKNOWLEDGEMENTS: The author thanks Christian Herbeaux from SOLEIL for valuable advices and Laurence Loiacono for the make-up of this paper.